Rain, *ôco* (= water).
it rains, *ôcooi.*
Red, *ma.*
bright red, *malay.*
Relation, male, *xoyque.*
female, *xoyco.*
Road, *ma-a.*
Round, *cahua.*
Salt, *hazi*, or *anzi*, or *quena ocha*, or *o-a*, or *teve.*
to salt, *anzi pegenaye.*
Scorpion, *puny.*
See, to, *inaye.*
Seed, grain, *ca.*
Servant, slave, *joya.*
Shaman, priest, *viniapain* (see "To foretell").
Shoulders, *ete.*
Silver, *rehua.*
Sin, *coa-yoye* (see "Bad").
Sleep, to, *cane.*
Smell, to, *yeye-ye.*
Small, little, *arimania.*
Smoke, *pia.*
Soul, *joyo* (see "Heart").
Spittle, *co-o.*
Spring, fountain, *oco renia* (see "Water").
Star, *manûco.*
the Pleiades, *vze po.*
Stick, *tarapue.*
Stone, *quena.*
Straw, *taya juinze.*
Sun, *nçe*, or *ense.*
the sun rises, *nçe nantaji.*
Talk, to, *n-caye*, or *cocacaye.*
speech or words, *caye.*
language, *coca.*
Thief, *naaque.*
Tiger, *ayro-yay* (see "Woods," "Dog").
Time, *rem.*
Tobacco, *mueto.*
in powder, *xea*, or *xena mueto.*
To-day, *yure.*
Tongue, the, *zemeno, zemeyo.*
Town, village, *quero*, or *taco*, or *raripue* (see "Place").
Turtle, *cohue*, or *puca*, or *taxeya.*
Urine, *cone.*
Water, *ôco.*
drinking water, *ocoraca.*
clear water, *cositaye oco.*
Weight, *requexi.*
to weigh in a balance, *cuencuesi.*
Wind, *tutu.*
Wish, to, *yeye.*
White, *poo.*
Woods, forest, *ayro*, or *mue.*
Yellow, *zeno, zonio*, or *paco*
Yesterday, *niamina.*

On the Phylogeny of the Vertebrata.

By E. D. Cope.

(*Read before the American Philosophical Society, October 7, 1892.*)

I have traced the origin* of the Mammalia to the Theromorous reptiles of the Permian epoch, for the following reasons. The latter include the Pelycosauria, Cotylosauria, Procolophonina and perhaps other orders. In both classes there is only one postorbital arch of the skull, and this is the zygomatic. In both (excepting Prototheria and Procolophonina†)

* Proceeds. Amer. Philos. Soc., 1884, p. 43.
† Seeley, Philos. Trans. Royal Soc., 1889, 269.

the coracoid element is of reduced size, and is coössified with the scapula. In both (except Cotylosauria) the capitular articulation of the ribs is intercentral. In both, the humerus has distal condyles and epicondyles, and there is an entepicondylar foramen in the Pelycosauria as in the lower Mammalia. The posterior foot is constructed in the Pelycosauria almost exactly like that of the Prototheria. The single occipital condyle of the reptiles is not found in the Mammalia, but in some of the Lacertilia (Uroplates, Gecco) there are two condyles, the median (basioccipital) portion of the single condyle being rudimental. The Pelycosauria could not, however, have given origin to the Prototheria, since in that subclass of mammals there is a well-developed coracoid. But in the Procolophonina this element is developed as in the Prototheria. Moreover, the Pelycosauria and the Procolophonina have the interclavicle, which is an element of membranous origin, while in the Prototheria we have the corresponding cartilage bone, the episternum. This element is present in the Permian order of the Cotylosauria, which is nearly related to the Pelycosauria. This order has, however, single-headed ribs, springing from the diapophyses, which is not usual in the Mammalia. But in some Cotylosauria the diapophyses are short, and in the Monotremata the postcervical ribs are single-headed, so this character may not prove an insurmountable one. It is evident that the Mammalia were derived from some type probably referable to a Permian reptilian order of the Theromorous series, although to which one is not yet known.

The Reptilia have been supposed by Hæckel to have taken their origin from the Batrachia. I have indicated that it is probable that the Batrachian order, which stands in this relation to the Reptilia, is the Embolomeri of the Permian epoch. This conclusion rests on the following considerations. The Reptilian order of the Cotylosauria approaches the Batrachia of the subclass Stegocephali in the overroofing of the posterior regions of the skull ; in the presence of vomerine teeth, and in the absence of obturator foramen of the pelvis. In some Cotylosauria (Diadectidæ) the stegocephalian intercalary bone of the skull is well developed. But in the Cotylosauria, the vertebral column consists mainly of centra, while in the Stegocephali it consists entirely or partly of intercentra. But in the Embolomeri the centra are well developed, and are larger than the intercentra anterior to the pelvis. Hence this is the only order of Stegocephali from which the Reptilia could have been derived.

Hæckel derived the Batrachia from the Dipnoi (Dipneusta), and I followed him in this belief, being strengthened in it by Huxley's ascription of an autostylic suspensorium of the mandible* to both divisions. This phylogeny is questioned by Pollard† and by Kingsley‡ who would see the ancestry of the Batrachia in the Crossopterygian fishes on embryological grounds derived from a study of Polypterus. In support of their

* Proceedings Zoölogical Society of London, 1876, p. 59.

† Anatomischer Anzeiger, vi, p. 338, 1891.

‡ American Naturalist, 1892, p. 679. Kingsley would also derive the Dipnoi from Crossopterygia.

view I would cite the absence of the maxillary arch in the Dipnoi, and its full development in the Stegocephali, which are the ancestral Batrachia. The large development of the dorsal and anal fins in the Dipnoi is not favorable to the Hæckelian view; nor do the paired fins approach as nearly to the limbs of Batrachia as do those of some other fishes. It has been shown by Huxley that the suspensorium of the Batrachia is hyostylic in its earliest stages, and that it becomes autostylic at a later period of development. The Batrachia may then have originated from a hyostylic Teleostomous fish; *i. e.*, one with complete maxillary arch. Among Teleostomata we naturally look for forms with limbs which approach nearest the Batrachian type, and in which median fins are feeble or wanting. Such are the Rhipidopterygia, which include the families of Holoptychiidæ, Tristichopteridæ, Osteolepididæ, Cœlacanthidæ and perhaps some others. These families, except the last, abounded in the waters of the Devonian period, at the time when the ancestors of the Batrachia also

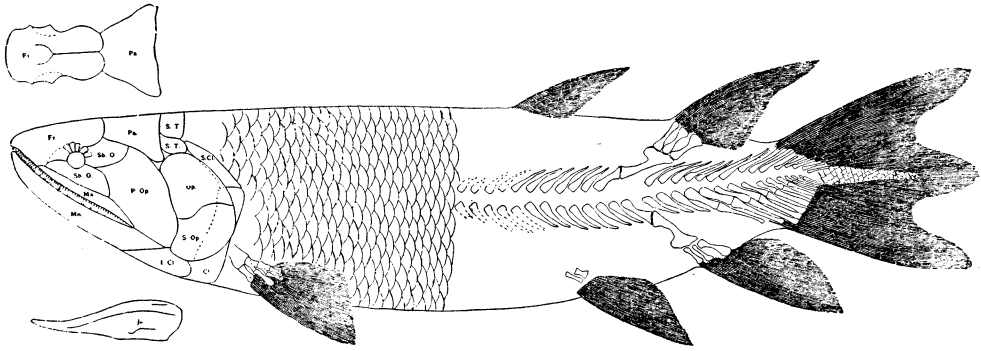

Fig. 1. *Eusthenopteron foordii* Whiteaves; ⅛ natural size. Devonian of New Brunswick. From Whiteaves.

existed. All of them agree in possessing the median fins of greatly reduced proportions, and the mesodermal or internal elements of the paired fins more like the limbs of the Batrachia than are those of any known fishes. The constitution of the superior cranial wall is a good deal like that of the stegocephalous Batrachia. The characters of the fins can be learned from the accompanying figure of the *Eusthenopteron foordii* Whiteaves, one of the Tristichopteridæ. The pectoral fin well-nigh realizes Gegenbaur's theory of the derivation of the Chiropterygium from the Archipterygium.

The question of the ancestry of the Batrachia cannot be considered to be yet settled.

The ancestral type of fishes is probably the Ichthyotomous order of the subclass of sharks (Elasmobranchii).* They are hyostylic, and have cranial

*Cope, Proceedings Amer. Philos. Soc., 1884, p. 585.

segmentation, the basioccipital element being conspicuous. The fins are all primitive, and those of all other types of fishes might have been derived from them. Opposed to this estimate of their relation to other vertebrates is the fact that they have not been yet found prior to the Carboniferous period. But our knowledge of the fishes of the Devonian is yet very imperfect. The types ancestral to the Pisces must have existed in the Silurian, and forms which may well have fulfilled this function have been discovered there. I refer to the Agnatha, which have been traced to the summit of the Devonian. The Silurian Agnatha are the Pteraspididæ, which display the lowest type, and the Cephalaspididæ, and these were succeeded by the Pterichthyidæ in the Devonian. There is a wide gap between these forms and any of the fishes, and nothing can be affirmed plausibly with regard to the phylogeny. There are superficial resemblances between the dorsal and ventral dermal scuta of the Pterichthyidæ and the Arthrodirous Dipnoi, but there is no considerable affinity between those divisions.

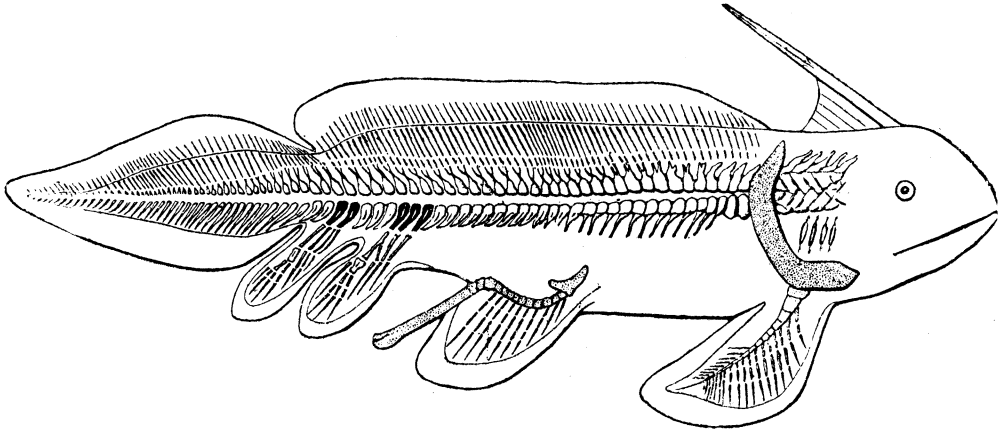

Fig. 2. *Xenacanthus dechenii*, one of the Ichthyotomi; restored by Dr. H. E. Sauvage. From the Coal Measures of France.

The extinct Agnatha agree with the existing lampreys in the absence of lower jaw and pectoral (scapular) arch, and both must be traced, in accordance with Hæckel's phylogeny, to the Acrania, which is now represented by the amphioxus (genus Branchiostoma). This order is easily the ancestor of existing Vertebrata, and shows points of resemblance to both Tunicata and worms. It has been suspected by Dohrn to have undergone degeneration, which may have been the case, since this phenomenon is so abundantly exhibited by both Tunicata and worms. It is not difficult to believe with Kowelewsky, that the Acrania were derived from the Tunicata. Semper has suspected, on the other hand, that the ancestors of the Vertebrata are to be found in the Annelide worms.